

Population structure, feeding biology and predation impact of midwater fishes in predator feeding areas around Heard and McDonald Islands, Southern Indian Ocean

by

Richard WILLIAMS*, Brian P.V. HUNT, Stevie R. DAVENPORT
& Timothy D. LAMB (1)

As part of an integrated programme to study the foraging behaviour of vertebrate predators and the availability of their prey in the vicinity of Heard Island, day and night sampling for macrozooplankton and nekton was conducted in the foraging areas of King penguins (*Aptenodytes patagonicus* Miller, 1778) (oceanic waters to the south-east of the Heard Island Plateau), Macaroni penguins (*Eudyptes chrysolophus* Brandt, 1837) (plateau top and slope south-east of Heard Island) and Antarctic Fur seals (*Arctocephalus gazella* (Peters, 1875)) (central Heard Island Plateau), in January 2004.

Heard Island lies to the south of the northern branch of the Polar Front, and thus, unlike at the Kerguelen Islands, the marine fauna is dominated by Antarctic Zone and Polar Frontal Zone species. The species composition of nekton reflects the environmental conditions in the three areas. The oceanic nature of the King penguin area is represented by a wide range of myctophid fishes, the most abundant of which were *Electrona antarctica* Günther, 1878, *Krefftichthys anderssoni* (Lönnerberg, 1905) and *Gymnoscopelus braueri* (Lönnerberg, 1905), which all have a broadly Antarctic distribution. The Fur seal foraging area, by contrast, was characterised by the absence of all myctophids except *Gymnoscopelus nicholsi* (Gilbert, 1911) and their replacement with the shallow water shelf members of the family Channichthyidae (*Champsoccephalus gunnari* Lönnerberg, 1905 and *Channichthys rhinoceratus* Richardson, 1844). The Macaroni penguin feeding area was intermediate in nature, sharing faunal elements with both the other areas. This reflects the physical nature of the area of plateau-top and slope subject to oceanographic influences from both the oceanic and plateau areas.

The diel vertical migration of most fish species was very strong, with many species migrating from the mesopelagic layer during the day to the epipelagic layers at night. An exception was *K. anderssoni* which was most abundant in the epipelagic layers during the day, especially in the King penguin foraging area.

The Prey Impact Index (PII), which combines fish abundance, proportion of fish feeding and mass of prey taken, reveals the extent of resource partitioning between the fish species. This is a result of a combination of different diets and the effects of different vertical migration patterns. In the King and Macaroni penguins foraging

areas, *K. anderssoni* was a specialist copepod feeder in the top 100 m by day, and to a lesser extent below 100 m at night. The principal predators at night were *G. braueri* which had an impact on all prey groups except copepods, *E. antarctica* (not copepods or euphausiids) and *G. nicholsi* which had most impact on the euphausiid *Thysanoessa* sp. and the amphipod *Themisto gaudichaudii* Guérin, 1825. There were some differences between the King and Macaroni penguins foraging areas, the main one being that in the latter *G. nicholsi* replaced *G. braueri* as the dominant predator at night which is consistent with proximity of this foraging area to the plateau. In the Fur seal foraging area, *C. gunnari* and *G. nicholsi* were both active at night but *G. nicholsi* had the greatest impact on copepods, euphausiids, furcilia and pteropods, whereas *C. gunnari* had the greatest impact on euphausiids, amphipods and ostracods.

The diel vertical migration patterns have important implications for the availability of prey to the seabird and seal predators. The King penguins, foraging during the day and diving generally in the top 100 m (Wienecke and Robertson, 2006), took mainly *K. anderssoni*, coinciding with the observed temporal and spatial distribution of this prey species. The Macaroni penguins also foraged during the day near the shelf break to the south-east of the island, in the top 100 m (Deagle *et al.*, 2007). Their diet was 84% euphausiids and 16% *K. anderssoni* by mass. Although *K. anderssoni* was much less abundant than in the King penguin foraging area, it was still the most common fish species at this depth during the day. The majority of Fur seal dives took place during the night in a depth range of 15 to 40 m and the two most common fish species in the Fur seal foraging area, *C. gunnari* and *G. nicholsi* together, contributed 94% of the seals' energy intake (Casper *et al.*, 2007). These two species both showed a weak upward migration at night, which would have taken them into the seals' diving range.

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(1) Australian Antarctic Division, Channel Highway, Kingston, Tasmania 7050, Australia. [bhunt@eos.ubc.ca] [steviedavenport@broadnet.com.au] [tim.lamb@aad.gov.au]

* Corresponding author [dick_wil@antdiv.gov.au]

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